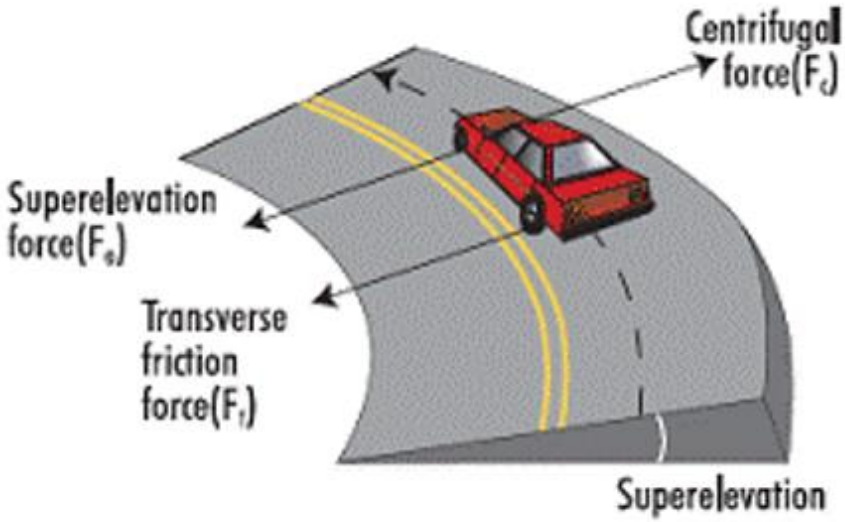
السوبر ايلفيشن

Superelevation

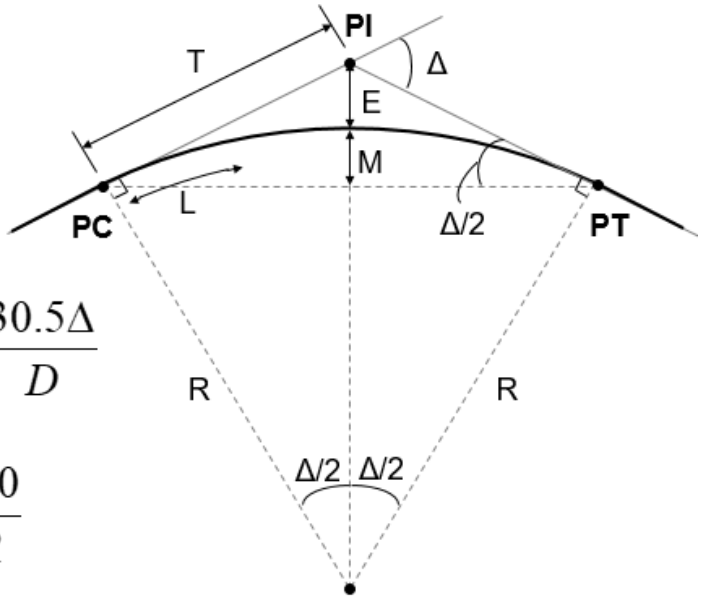


Horizontal Curve Fundamentals

$$T = R\tan\frac{\Delta}{2}$$

$$L = \frac{\pi}{180}R\Delta = \frac{30.5\Delta}{D}$$

$$D = \frac{1750}{R}$$



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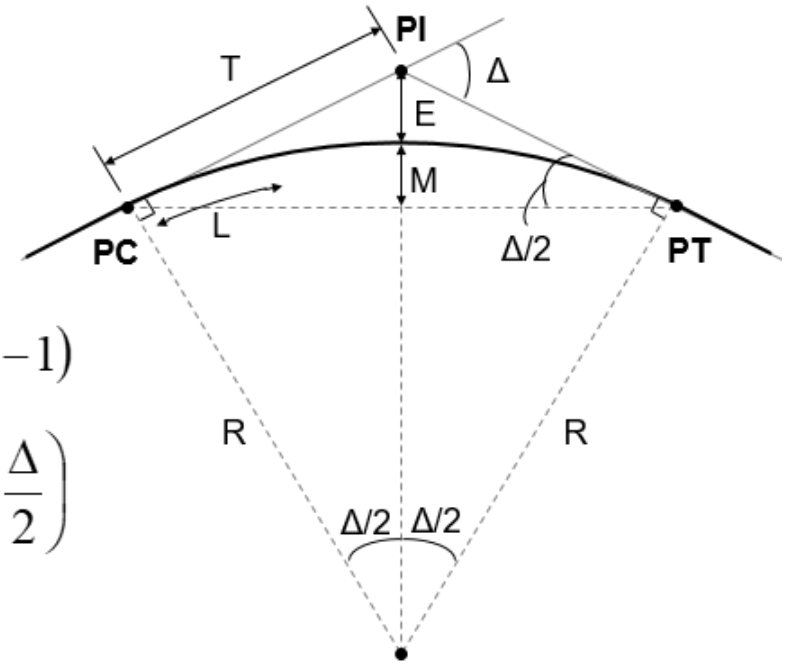
Horizontal Curve Fundamentals

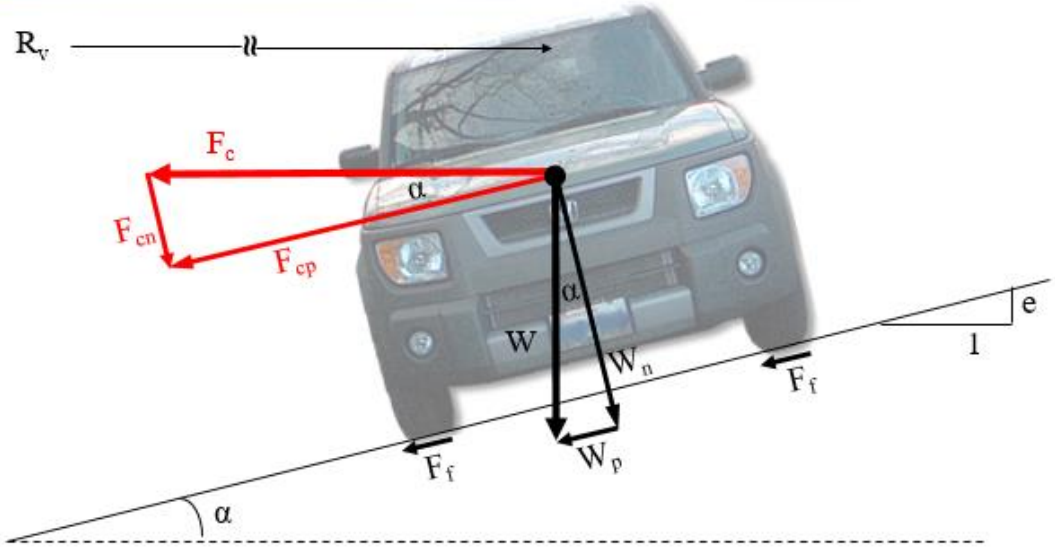


$$E = R\left(Sec\Delta/2 - 1\right)$$

$$M = R\left(1 - \cos\frac{\Delta}{2}\right)$$

Superelevation

$$W_p + F_f = F_{cp}$$



$$W\sin\alpha + f_s\left(W\cos\alpha + \frac{WV^2}{gR_v}\sin\alpha\right) = \frac{WV^2}{gR_v}\cos\alpha$$

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Superelevation

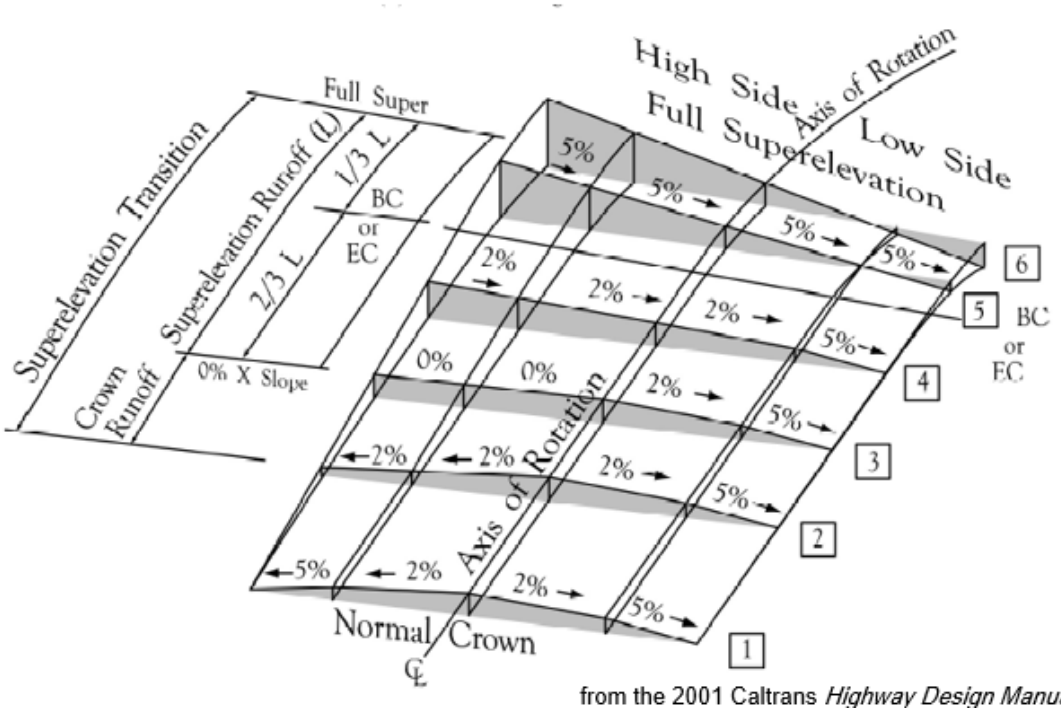
$$W\sin\alpha + f_s\left(W\cos\alpha + \frac{WV^2}{gR_v}\sin\alpha\right) = \frac{WV^2}{gR_v}\cos\alpha$$

$$\tan\alpha + f_s = \frac{V^2}{gR_v}\left(1 - f_s\tan\alpha\right)$$

$$e + f_s = \frac{V^2}{gR_v}\left(1 - f_s e\right)$$

$$e + f_s = \frac{V^2}{127R}$$

Superelevation Transition



from the 2001 Caltrans *Highway Design Manual*

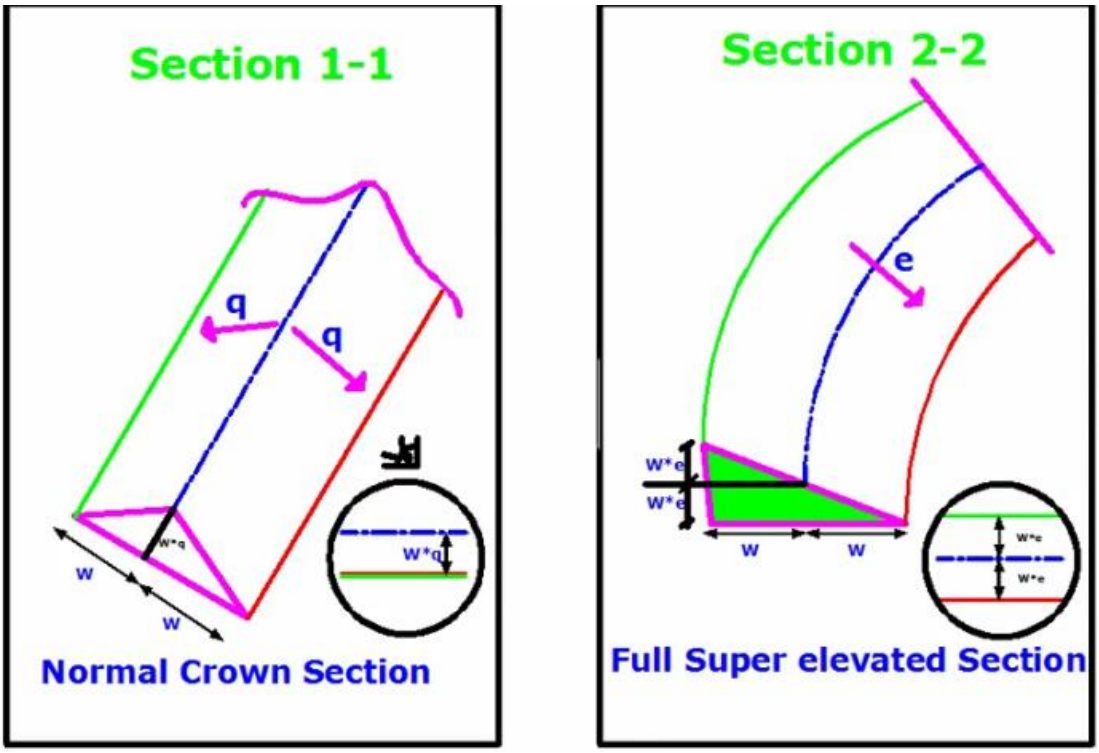
Minimum Radius Tables e_{max} = 4%

الرفع الجانبي (e), %	الحد الأدنى لنصف القطر (R_{min}) عند (V_d) تساوي								
	٢٠	٣٠	٤٠	٥٠	٦٠	٧٠	٨٠	٩٠	١٠٠
١,٥	١٦٣	٣٧١	٦٧٩	٩٥١	١٣١٠	١٧٤٠	٢١٧٠	٢٦٤٠	٣٢٥٠
٢,٠	١٠٢	٢٣٧	٤٤١	٦٣٢	٨٧٧	١١٨٠	١٤٩٠	١٨٣٠	٢٢٦٠
٢,٢	٧٥	١٨٧	٣٦٣	٥٣٤	٧٤٩	١٠٢٠	١٢٩٠	١٥٩٠	١٩٨٠
٢,٤	٥١	١٣٢	٢٧٣	٤٣٥	٦٢٦	٨٦٥	١١١٠	١٣٩٠	١٧٣٠
٢,٦	٣٨	٩٩	٢٠٩	٣٤٥	٥٠٨	٧٢٠	٩٤٤	١٢٠٠	١٥١٠
٢,٨	٣٠	٧٩	١٦٧	٢٨٣	٤٢٢	٦٠٥	٨٠٢	١٠٣٠	١٣٢٠
٣,٠	٢٤	٦٤	١٣٧	٢٣٦	٣٥٦	٥١٦	٦٩٠	٨٩٣	١١٥٠
٣,٢	٢٠	٥٤	١١٤	١٩٩	٣٠٣	٤٤٣	٥٩٧	٧٧٩	١٠١٠
٣,٤	١٧	٤٥	٩٦	١٧٠	٢٦٠	٣٨٢	٥١٨	٦٨٠	٨٧٩
٣,٦	١٤	٣٨	٨١	١٤٤	٢٢٢	٣٢٩	٤٤٨	٥٩١	٧٦٧
٣,٨	١٢	٣١	٦٧	١٢١	١٨٧	٢٧٨	٣٨١	٥٠٥	٦٥٨
٤,٠	٨	٢٢	٤٧	٨٦	١٣٥	٢٠٣	٢٨٠	٣٧٥	٤٩٢

Friction Factor (Fs)

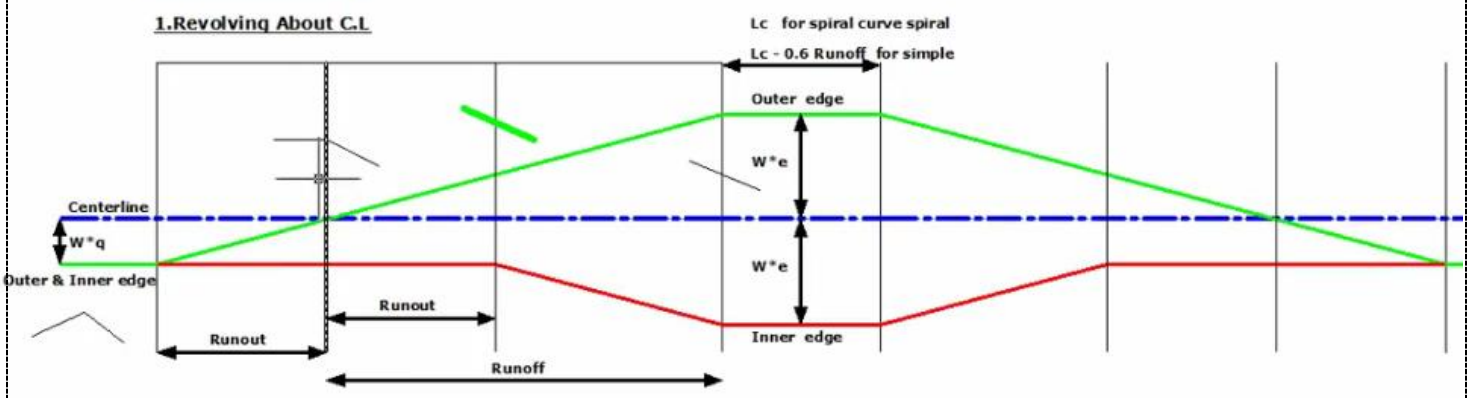
Maximum safe side Friction factor (f_s)

Design speed, kph	Side friction factor (f_s)
40	0.17
50	0.16
60	0.15
70	0.15
80	0.14
90	0.13
100	0.13
110	0.12
120	0.12

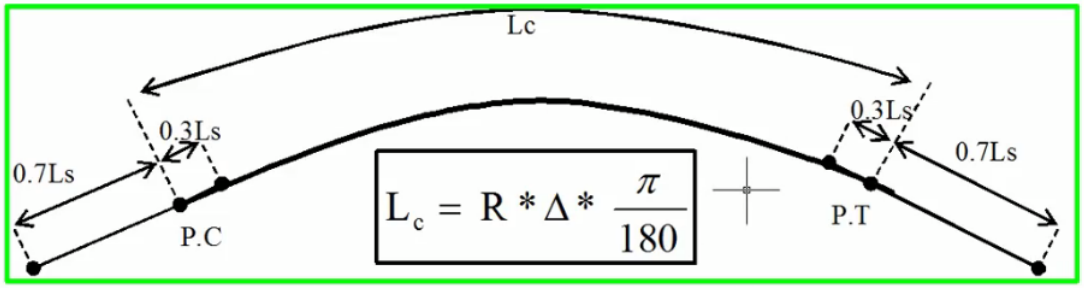


Methods of Attining Superelevation Rate

Undivided HWY



Simple Curve [curve without Spiral]



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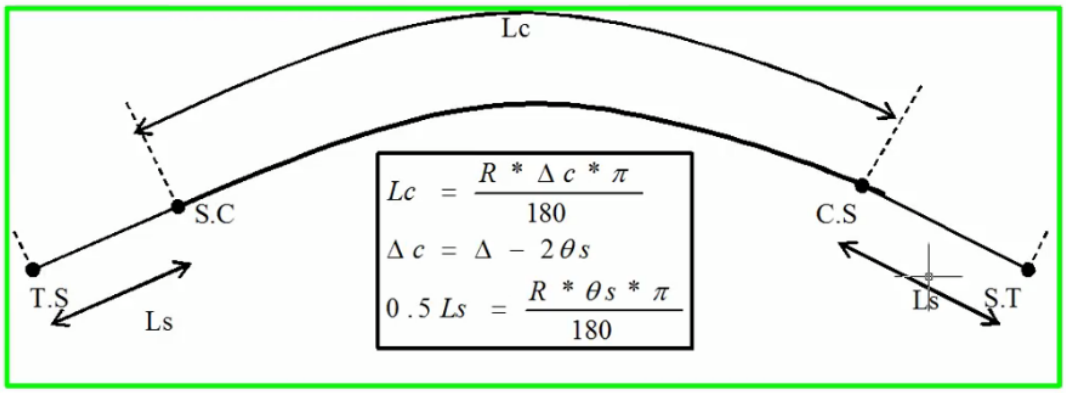
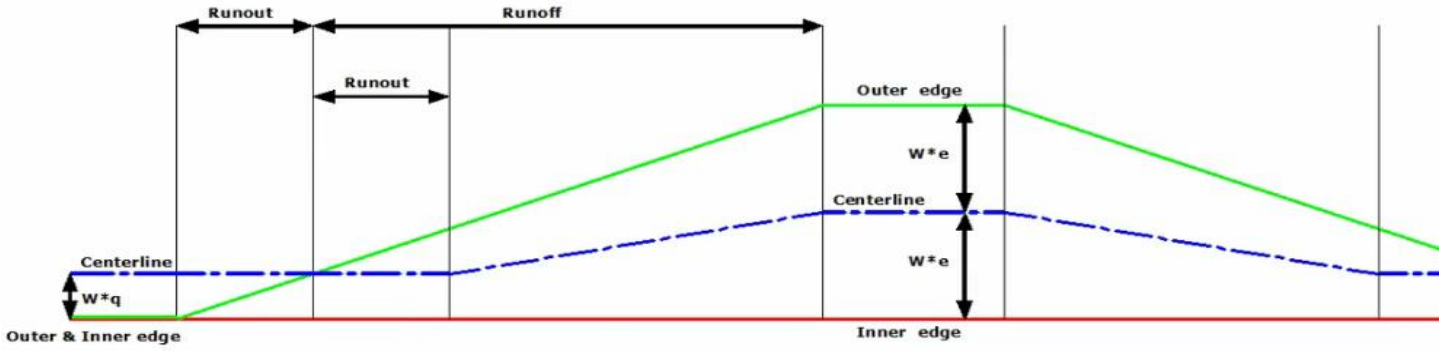
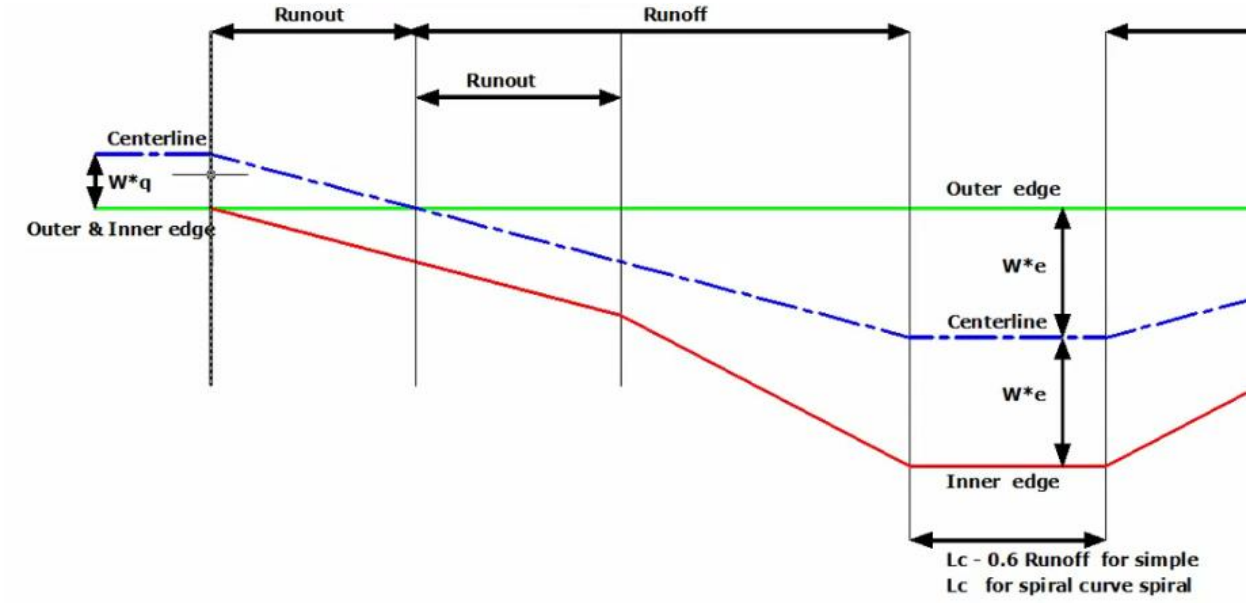
Spiral - Curve - Spiral [curve with Spiral]



2.Revolving About I.E





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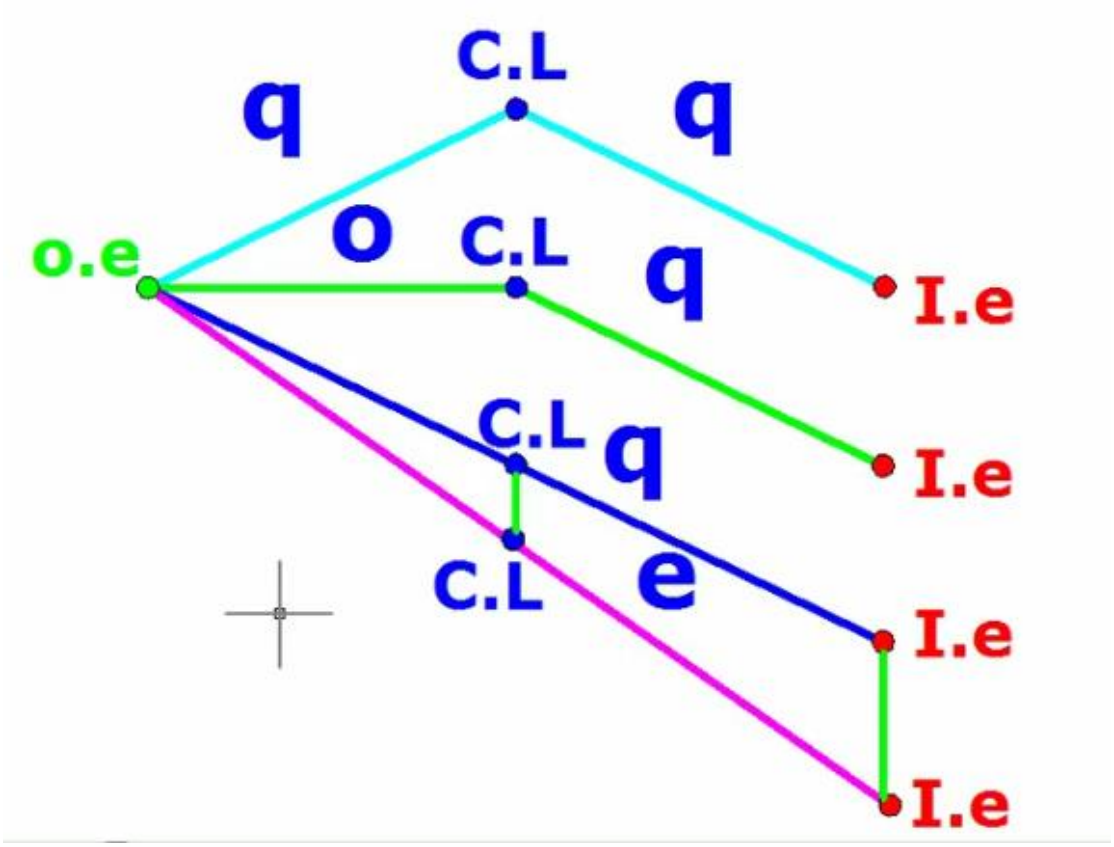

Runoff (Ls) = max.
- $\frac{V^3}{28R}$
- $\frac{A^2}{R}$
- $\frac{W * e}{\Delta S} f$ Revolve about ***centerline*** or ***outer edge***
- $\frac{2We - Wq}{2\Delta S} f$ Revolve about ***inner edge***

$$\text{Run out(X)} = \frac{q}{e} * L \rightarrow \textit{rotation about } C.L \textit{ or } O.e$$

$$\text{Run out(X)} = \frac{q}{2 * e - q} * L \rightarrow \textit{rotation about } I.e$$

Where :

V : Speed , kph السرعة

R: radius of curve نصف القطر

A : spiral parameter معامل التفلطح

W: Lane width عرض الحارة

e: superelevation rate ميل الظهر عن البطن

q: normal crown slope %2 مالم يذكر يفرض

Δs: Relative slope الميل النسبي بين محور الطريق واحد حوافه

Design speed, Kph	40	60	80	100	120	140
Min. Spiral parameter(A)	50	100	150	200	350	500

Design speed	30	50	65	80	100	105
Max. relative slope%(Δs)	0.75	0.67	0.58	0.5	0.45	0.41

Total lanes of HWY	2	4	6
Factor F	1	1.5	2